

that must be installed between the valve and remote actuator to provide manual and thermal on-truck remote means of closure.

[Order 59-B, 30 FR 579, Jan. 16, 1965. Redesignated at 32 FR 5606, Apr. 5, 1967]

EDITORIAL NOTE: For FEDERAL REGISTER citations affecting § 178.337-1, see the List of CFR Sections Affected which appears in the Finding Aids section of the printed volume and on GPO Access.

§ 178.337-2 Material.

(a) *General.* (1) All material used for construction of the cargo tank and appurtenances must be suitable for use with the commodities to be transported therein and must conform to the requirements in Section II of the ASME Code (IBR, see § 171.7 of this subchapter) and/or requirements of the American Society for Testing and Materials in all respects.

(2) Impact tests are required on steel used in the fabrication of each cargo tank constructed in accordance with part UHT in Section VIII of the ASME Code. The tests must be made on a lot basis. A lot is defined as 100 tons or less of the same heat treatment processing lot having a thickness variation no greater than plus or minus 25 percent. The minimum impact required for full size specimens must be 20 foot-pounds in the longitudinal direction at -30°F. , Charpy V-Notch and 15 foot-pounds in the transverse direction at -30°F. , Charpy V-Notch. The required values for subsize specimens must be reduced in direct proportion to the cross-sectional area of the specimen beneath the notch. If a lot does not meet this requirement, individual plates may be accepted if they individually meet this requirement.

(3) The fabricator shall record the heat, and slab numbers, and the certified Charpy impact values, where required, of each plate used in each cargo tank on a sketch showing the location of each plate in the shell and heads of the cargo tank. Copies of each sketch shall be provided to the owner and retained for at least five years by the fabricator and made available to duly identified representatives of the Department of Transportation.

(4) The direction of final rolling of the shell material shall be the circum-

ferential orientation of the cargo tank shell.

(b) *For a chlorine cargo tank.* Plates, the manway nozzle, and anchorage shall be made of carbon steel which meets the following requirements:

(1) For a cargo tank manufactured on or before December 31, 1974—

(i) Material shall conform to ASTM A 300, "Steel Plates for Pressure Vessels for Service at Low Temperatures" (IBR, see § 171.7 of this subchapter);

(ii) Material shall be Class 1, Grade A, flange or firebox quality;

(iii) Plate impact test specimens, as required under paragraph (a) of this section, shall be of the Charpy keyhole notch type; and

(iv) Plate impact test specimens shall meet the impact test requirements in paragraph (a) of this section in both the longitudinal and transverse directions of rolling at a temperature of minus 45.5°C. (-50°F.).

(2) For a cargo tank manufactured on or after January 1, 1975—

(i) Material shall conform to ASTM A 612 (IBR, see § 171.7 of this subchapter), Grade B or A 516/A 516M (IBR, see § 171.7 of this subchapter), Grade 65 or 70;

(ii) Material shall meet the Charpy V-notch test requirements of ASTM A 20/A 20M (IBR, see § 171.7 of this subchapter); and

(iii) Plate impact test specimens shall meet the impact test requirements in paragraph (a) of this section in both the longitudinal and transverse directions of rolling at a temperature of minus 40°C. (-40°F.).

(c) A cargo tank in anhydrous ammonia service must be constructed of steel. The use of copper, silver, zinc or their alloys is prohibited. Baffles made from aluminum may be used only if joined to the cargo tank by a process not requiring postweld heat treatment of the cargo tank.

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§ 178.337-3 Structural integrity.

(a) General requirements and acceptance criteria. (1) Except as provided in

paragraph (d) of this section, the maximum calculated design stress at any point in the cargo tank may not exceed the maximum allowable stress value prescribed in Section VIII of the ASME Code (IBR, see §171.7 of this subchapter), or 25 percent of the tensile strength of the material used.

(2) The relevant physical properties of the materials used in each cargo tank may be established either by a certified test report from the material manufacturer or by testing in conformance with a recognized national standard. In either case, the ultimate tensile strength of the material used in the design may not exceed 120 percent of the ultimate tensile strength specified in either the ASME Code or the ASTM standard to which the material is manufactured.

(3) The maximum design stress at any point in the cargo tank must be calculated separately for the loading conditions described in paragraphs (b), (c), and (d) of this section. Alternate test or analytical methods, or a combination thereof, may be used in place of the procedures described in paragraphs (b), (c), and (d) of this section, if the methods are accurate and verifiable.

(4) Corrosion allowance material may not be included to satisfy any of the design calculation requirements of this section.

(b) *Static design and construction.* (1) The static design and construction of each cargo tank must be in accordance with Section VIII of the ASME Code. The cargo tank design must include calculation of stresses generated by design pressure, the weight of lading, the weight of structure supported by the cargo tank wall, and the effect of temperature gradients resulting from lading and ambient temperature extremes. When dissimilar materials are used, their thermal coefficients must be used in calculation of thermal stresses.

(2) Stress concentrations in tension, bending and torsion which occur at pads, cradles, or other supports must be considered in accordance with appendix G in Section VIII of the ASME Code.

(c) *Shell design.* Shell stresses resulting from static or dynamic loadings, or combinations thereof, are not uniform

throughout the cargo tank motor vehicle. The vertical, longitudinal, and lateral normal operating loadings can occur simultaneously and must be combined. The vertical, longitudinal and lateral extreme dynamic loadings occur separately and need not be combined.

(1) *Normal operating loadings.* The following procedure addresses stress in the tank shell resulting from normal operating loadings. The effective stress (the maximum principal stress at any point) must be determined by the following formula:

$$S = 0.5(S_y + S_x) \pm [0.25(S_y - S_x)^2 + S_z^2]^{0.5}$$

Where:

(i) S = effective stress at any given point under the combination of static and normal operating loadings that can occur at the same time, in psi.

(ii) S_y = circumferential stress generated by the MAWP and external pressure, when applicable, plus static head, in psi.

(iii) S_x = The following net longitudinal stress generated by the following static and normal operating loading conditions, in psi:

(A) The longitudinal stresses resulting from the MAWP and external pressure, when applicable, plus static head, in combination with the bending stress generated by the static weight of the fully loaded cargo tank motor vehicle, all structural elements, equipment and appurtenances supported by the cargo tank wall;

(B) The tensile or compressive stress resulting from normal operating longitudinal acceleration or deceleration. In each case, the forces applied must be 0.35 times the vertical reaction at the suspension assembly, applied at the road surface, and as transmitted to the cargo tank wall through the suspension assembly of a trailer during deceleration; or the horizontal pivot of the truck tractor or converter dolly fifth wheel, or the drawbar hinge on the fixed dolly during acceleration; or anchoring and support members of a truck during acceleration and deceleration, as applicable. The vertical reaction must be calculated based on the static weight of the fully loaded cargo tank motor vehicle, all structural elements, equipment and appurtenances

supported by the cargo tank wall. The following loadings must be included:

(1) The axial load generated by a decelerative force;

(2) The bending moment generated by a decelerative force;

(3) The axial load generated by an accelerative force; and

(4) The bending moment generated by an accelerative force; and

(C) The tensile or compressive stress generated by the bending moment resulting from normal operating vertical accelerative force equal to 0.35 times the vertical reaction at the suspension assembly of a trailer; or the horizontal pivot of the upper coupler (fifth wheel) or turntable; or anchoring and support members of a truck, as applicable. The vertical reaction must be calculated based on the static weight of the fully loaded cargo tank motor vehicle, all structural elements, equipment and appurtenances supported by the cargo tank wall.

(iv) S_s = The following shear stresses generated by the following static and normal operating loading conditions, in psi:

(A) The static shear stress resulting from the vertical reaction at the suspension assembly of a trailer, and the horizontal pivot of the upper coupler (fifth wheel) or turntable; or anchoring and support members of a truck, as applicable. The vertical reaction must be calculated based on the static weight of the fully loaded cargo tank motor vehicle, all structural elements, equipment and appurtenances supported by the cargo tank wall;

(B) The vertical shear stress generated by a normal operating accelerative force equal to 0.35 times the vertical reaction at the suspension assembly of a trailer; or the horizontal pivot of the upper coupler (fifth wheel) or turntable; or anchoring and support members of a truck, as applicable. The vertical reaction must be calculated based on the static weight of the fully loaded cargo tank motor vehicle, all structural elements, equipment and appurtenances supported by the cargo tank wall;

(C) The lateral shear stress generated by a normal operating lateral accelerative force equal to 0.2 times the vertical reaction at each suspension as-

sembly of a trailer, applied at the road surface, and as transmitted to the cargo tank wall through the suspension assembly of a trailer, and the horizontal pivot of the upper coupler (fifth wheel) or turntable; or anchoring and support members of a truck, as applicable. The vertical reaction must be calculated based on the static weight of the fully loaded cargo tank motor vehicle, all structural elements, equipment and appurtenances supported by the cargo tank wall; and

(D) The torsional shear stress generated by the same lateral forces as described in paragraph (c)(1)(iv)(C) of this section.

(2) *Extreme dynamic loadings.* The following procedure addresses stress in the tank shell resulting from extreme dynamic loadings. The effective stress (the maximum principal stress at any point) must be determined by the following formula:

$$S = 0.5(S_y + S_x) \pm [0.25(S_y - S_x)^2 + S_z^2]^{0.5}$$

Where:

(i) S = effective stress at any given point under a combination of static and extreme dynamic loadings that can occur at the same time, in psi.

(ii) S_y = circumferential stress generated by MAWP and external pressure, when applicable, plus static head, in psi.

(iii) S_x = the following net longitudinal stress generated by the following static and extreme dynamic loading conditions, in psi:

(A) The longitudinal stresses resulting from the MAWP and external pressure, when applicable, plus static head, in combination with the bending stress generated by the static weight of the fully loaded cargo tank motor vehicle, all structural elements, equipment and appurtenances supported by the tank wall;

(B) The tensile or compressive stress resulting from extreme longitudinal acceleration or deceleration. In each case the forces applied must be 0.7 times the vertical reaction at the suspension assembly, applied at the road surface, and as transmitted to the cargo tank wall through the suspension assembly of a trailer during deceleration; or the horizontal pivot of the truck tractor or converter dolly fifth

wheel, or the drawbar hinge on the fixed dolly during acceleration; or the anchoring and support members of a truck during acceleration and deceleration, as applicable. The vertical reaction must be calculated based on the static weight of the fully loaded cargo tank motor vehicle, all structural elements, equipment and appurtenances supported by the cargo tank wall. The following loadings must be included:

- (1) The axial load generated by a decelerative force;
- (2) The bending moment generated by a decelerative force;
- (3) The axial load generated by an accelerative force; and
- (4) The bending moment generated by an accelerative force; and

(C) The tensile or compressive stress generated by the bending moment resulting from an extreme vertical accelerative force equal to 0.7 times the vertical reaction at the suspension assembly of a trailer, and the horizontal pivot of the upper coupler (fifth wheel) or turntable; or the anchoring and support members of a truck, as applicable. The vertical reaction must be calculated based on the static weight of the fully loaded cargo tank motor vehicle, all structural elements, equipment and appurtenances supported by the cargo tank wall.

(iv) S_s = The following shear stresses generated by static and extreme dynamic loading conditions, in psi:

(A) The static shear stress resulting from the vertical reaction at the suspension assembly of a trailer, and the horizontal pivot of the upper coupler (fifth wheel) or turntable; or anchoring and support members of a truck, as applicable. The vertical reaction must be calculated based on the static weight of the fully loaded cargo tank motor vehicle, all structural elements, equipment and appurtenances supported by the cargo tank wall;

(B) The vertical shear stress generated by an extreme vertical accelerative force equal to 0.7 times the vertical reaction at the suspension assembly of a trailer, and the horizontal pivot of the upper coupler (fifth wheel) or turntable; or anchoring and support members of a truck, as applicable. The vertical reaction must be calculated based on the static weight of the fully

loaded cargo tank motor vehicle, all structural elements, equipment and appurtenances supported by the cargo tank wall;

(C) The lateral shear stress generated by an extreme lateral accelerative force equal to 0.4 times the vertical reaction at the suspension assembly of a trailer, applied at the road surface, and as transmitted to the cargo tank wall through the suspension assembly of a trailer, and the horizontal pivot of the upper coupler (fifth wheel) or turntable; or anchoring and support members of a truck, as applicable. The vertical reaction must be calculated based on the static weight of the fully loaded cargo tank motor vehicle, all structural elements, equipment and appurtenances supported by the cargo tank wall; and

(D) The torsional shear stress generated by the same lateral forces as described in paragraph (c)(2)(iv)(C) of this section.

(d) In order to account for stresses due to impact in an accident, the design calculations for the cargo tank shell and heads must include the load resulting from the design pressure in combination with the dynamic pressure resulting from a longitudinal deceleration of "2g". For this loading condition the stress value used may not exceed the lesser of the yield strength or 75 percent of the ultimate tensile strength of the material of construction. For cargo tanks constructed of stainless steel the maximum design stress may not exceed 75 percent of the ultimate tensile strength of the type steel used.

(e) The minimum metal thickness for the shell and heads on tanks with a design pressure of 100 psig or more must be 4.75 mm (0.187 inch) for steel and 6.86 mm (0.270 inch) for aluminum, except for chlorine and sulfur dioxide tanks. In all cases, the minimum thickness of the tank shell and head shall be determined using structural design requirements in Section VIII of the ASME Code or 25% of the tensile strength of the material used. For a cargo tank used in chlorine or sulfur dioxide service, the cargo tank must be made of steel. A corrosion allowance of 20 percent or 2.54 mm (0.10 inch), whichever is less, must be added to the thickness

otherwise required for sulfur dioxide and chlorine tank material. In chlorine cargo tanks, the wall thickness must be at least 1.59 cm (0.625 inch), including corrosion allowance.

(f) Where a cargo tank support is attached to any part of the cargo tank wall, the stresses imposed on the cargo tank wall must meet the requirements in paragraph (a) of this section.

(g) The design, construction, and installation of an attachment, appurtenance to the cargo tank, structural support member between the cargo tank and the vehicle or suspension component, or accident protection device must conform to the following requirements:

(1) Structural members, the suspension sub-frame, accident protection structures, and external circumferential reinforcement devices must be used as sites for attachment of appurtenances and other accessories to the cargo tank, when practicable.

(2) A lightweight attachment to the cargo tank wall such as a conduit clip, brake line clip, skirting structure, lamp mounting bracket, or placard holder must be of a construction having lesser strength than the cargo tank wall materials and may not be more than 72 percent of the thickness of the material to which it is attached. The lightweight attachment may be secured directly to the cargo tank wall if the device is designed and installed in such a manner that, if damaged, it will not affect the lading retention integrity of the tank. A lightweight attachment must be secured to the cargo tank shell or head by a continuous weld or in such a manner as to preclude formation of pockets which may become sites for corrosion. Attachments meeting the requirements of this paragraph are not authorized for cargo tanks constructed under part UHT in Section VIII of the ASME Code.

(3) Except as prescribed in paragraphs (g)(1) and (g)(2) of this section, the welding of any appurtenance to the cargo tank wall must be made by attachment of a mounting pad so that there will be no adverse effect upon the lading retention integrity of the cargo tank if any force less than that prescribed in paragraph (b)(1) of this section is applied from any direction. The

thickness of the mounting pad may not be less than that of the shell wall or head wall to which it is attached, and not more than 1.5 times the shell or head thickness. However, a pad with a minimum thickness of 0.25 inch may be used when the shell or head thickness is over 0.25 inch. If weep holes or tell-tale holes are used, the pad must be drilled or punched at the lowest point before it is welded to the tank. Each pad must—

(i) Be fabricated from material determined to be suitable for welding to both the cargo tank material and the material of the appurtenance or structural support member; a Design Certifying Engineer must make this determination considering chemical and physical properties of the materials and must specify filler material conforming to the requirements in Section VIII of the ASME Code (IBR, see §171.7 of this subchapter).

(ii) Be preformed to an inside radius no greater than the outside radius of the cargo tank at the attachment location.

(iii) Extend at least 2 inches in each direction from any point of attachment of an appurtenance or structural support member. This dimension may be measured from the center of the attached structural member.

(iv) Have rounded corners, or otherwise be shaped in a manner to minimize stress concentrations on the shell or head.

(v) Be attached by continuous fillet welding. Any fillet weld discontinuity may only be for the purpose of preventing an intersection between the fillet weld and a tank or jacket seam weld.

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§ 178.337-4 Joints.

(a) Joints shall be as required in Section VIII of the ASME Code (IBR, see §171.7 of this subchapter), with all undercutting in shell and head material repaired as specified therein.